

Ohio Department of Natural Resources

Monitoring seismic activity in Ohio, USA



Figure 1. 40T Posthole instruments were deployed in cased holes to depths of up to 10 metres

Summary

Ohio experiences relatively low magnitude events so it is important to have a low-noise seismic network to accurately locate and estimate the magnitude of events across the state. The state has also seen an increase over the past decade in oil and gas exploration which requires additional monitoring to ensure safe practices. The overall aim of installing the 40T sensors in posthole installations is to reduce the detection threshold of the network to be able to detect events down to Magnitude 1, therefore allowing the state Survey to better characterize seismic activity in the state.

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Background

Seismic station coverage of the US Midwest is sparse and has not been sufficient enough for in depth seismic studies since the Transportable Array (TA) was moved out of the region. Ohio Geological Survey is leading the way in the region to increase station density to the previous TA levels which will stimulate future investigations in the region.

Initially, the network transitioned from older shallow surface vaults, which used the digital Güralp 6TD instruments, to 10 m posthole stations using the Güralp 40T posthole instrument. The plan is for future stations to utilise the Güralp Certis, an ultra-compact medium motion seismometer that doesn't require levelling or orienting during deployment.

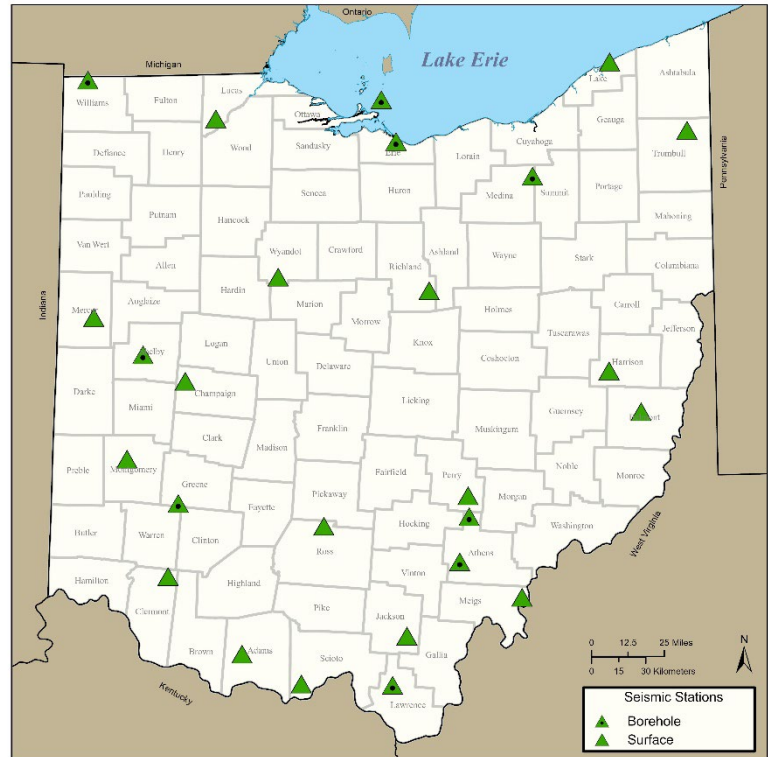


Figure 2. Ohio Seismic Network Monitoring Stations in 2021

Posthole deployments of instruments are a cost-effective method for improving station performance without the additional cost of building dedicated vaults. Even partial burial of the sensor can dramatically improve the signal-to-noise ratio of the collected data. Recent technological advances in sensor design and improved robustness have made the deployment of posthole sensors easier for network operators. This will be further improved with Certis because the need to orientate the sensor downhole will be removed.

Güralp Solution

This ongoing project began in summer 2021, with nine, 40T posthole sensors deployed into the network with Minimus digitizers.

The 40T posthole is a small, rugged seismometer suitable for installations in areas with moderate noise. The posthole variant is suitable for deployment where long-term submersion in fluid may occur.



Figure 3. 40T Posthole

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Güralp Solution cont.

The sensors were deployed in 10m postholes that were cased and had a levelled base of sand. The instruments were lowered into the holes using strain relief cable and a downhole camera assisted with orientating the sensors using a U-bolt on a pole. A plumb line was dropped from the surface to mark the direction of true north. The downhole camera also assisted with monitoring the bubble level as the instrument was levelled downhole.

The Minimus units were deployed in waterproof surface cases and cell modems were used to transfer data in real-time back to the Ohio Geological Survey data centre. The Minimus units provide quick and easily understood State-of-Health data to the network which allows the Survey to efficiently plan for any required station maintenance. For example, the adjustment of GPS antennas if the GPS lock is insufficient.



Figure 4. Minimus digitiser

The sensor vault was sealed with tarpaulin and covered in mulch to further protect against moisture ingress and weeds.



Figure 5. The 40T posthole instruments were deployed in cased holes to depths of down to 10 metres



Figure 6. The cased holes were then sealed with tarpaulin and covered in mulch to protect against moisture ingress



Figure 7. Stations are equipped with solar panel charged batteries to power the 40T Posthole and the Minimus digitiser, and with a cell modem to transmit the data to the network

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Outcome

The 40T sensors were deployed in summer 2021 and have dramatically increased the number of recorded events in the state.

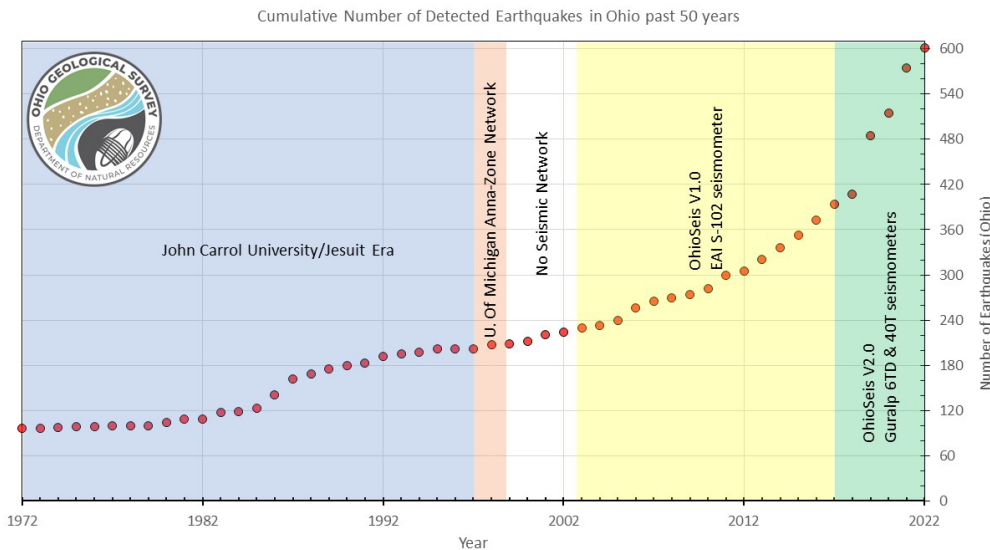


Figure 8. Cumulative number of detected earthquakes in Ohio in the past 50 years

The Ohio department of natural resources will now be able to catalogue a greater number of seismic events occurring in the state and therefore a larger database of events will be available for scientific investigation. The increased event data will be used for a wide range of studies including investigation of the central American continental craton and intraplate dynamics of the region.

“Güralp’s seismometers and technical support have helped us tremendously here in Ohio, ushering in a new era of seismic monitoring in the state. With these instruments, we truly have a research-grade regional seismic network and are equipped to detect any seismic activity in the region and process events in a very efficient manner.”

Jeffrey Fox, OhioSeis Seismic Network Manager/Seismologist, Ohio Geological Survey